WE CLAIM:

1. An antenna system, comprising:
a reflector having a modified-paraboloid shape; and
a multi-beam, multi-band feed array wherein:
said feed array is located close to a focal plane of said reflector;
said feed array includes at least one horn;
said feed array forms a plurality of beams, each of said plurality of beams being formed by a single horn of said feed array; and
said antenna system forms said plurality of beams so that each of said plurality of beams is congruent, and said plurality of beams is contiguous.

2. The antenna system of claim 1, wherein:
said reflector is the single reflector of said antenna system; and
said reflector surface is non-frequency selective.

3. The antenna system of claim 1, wherein:
said reflector is the single reflector of said antenna system; and
said reflector is constructed from a non-frequency selective, surface chosen from one of solid graphite or gold-molybdenum mesh reflector.

4. The antenna system of claim 1, wherein said reflector is an offset reflector.

5. The antenna system of claim 1, wherein said reflector is an axi-symmetric reflector.

6. The antenna system of claim 1, wherein:

said reflector is sized to produce a required beam size at a lowest frequency band; and

said reflector is oversized at a highest frequency band.

7. The antenna system of claim 1, wherein:

said reflector, having said modified-paraboloid shape, broadens a beam with moderate effect at a highest frequency band and at an intermediate frequency band and with minimal effect at a lowest frequency band.

8. The antenna system of claim 1, wherein:

said multi-beam, multi-band feed array comprises a plurality of circular horns.

9. The antenna system of claim 1, wherein:

said multi-beam, multi-band feed array comprises a plurality of horns wherein at least one of said plurality of horns is a circular horn and at least one of said plurality of horns is not a circular type of horn.

10. The antenna system of claim 1, wherein:

said multi-beam, multi-band feed array is focused at a lowest frequency band, wherein a lowest frequency horn phase center of said at least one horn is located close to said focal plane; and

said multi-beam, multi-band feed array is defocused at a highest frequency band and at an intermediate frequency band, wherein a highest frequency horn phase center and an intermediate frequency horn phase center are located behind said focal plane away from said reflector.

11. The antenna system of claim 10, wherein said lowest frequency horn phase center of said at least one horn is located at said focal plane.

12. The antenna system of claim 1, wherein:

said multi-beam, multi-band feed array comprises a plurality of feed horns; and

said feed horns are placed on a spherical cap with a radius of a distance from an aperture center of said reflector to said focal point, said radius of said spherical cap centered at the aperture center.

13. The antenna system of claim 1, further including a compact 6-port OMT/polarizer wherein said feed array provides dual-circular polarization capability at each of three distinct frequency bands.

14. The antenna system of claim 1, further including a beam forming network.

15. A reflector for an antenna system, comprising:

a non-frequency selective reflector surface, wherein:

said reflector surface has a modified-paraboloid shape;

said reflector is sized to produce a required beam size at a lowest frequency band; and

said reflector is oversized at a highest frequency band.

16. The reflector of claim 15, wherein said reflector is an offset reflector.

17. The reflector of claim 15, wherein said reflector is an axi-symmetric reflector.

18. The reflector of claim 15, wherein:

said reflector has a synthesized surface with a maximum peak-to-

peak variation from a parabolic surface of 0.11 inch.

19. The reflector of claim 15, wherein:

said reflector has a synthesized surface of modified-paraboloid shape; and

said synthesized surface is moderately shaped and disproportionately broadens higher frequency-band beams compared to lower frequency-band beams.

20. The reflector of claim 15, wherein:

said reflector has a synthesized surface of modified-paraboloid shape; and

said synthesized surface forms identically-sized beams of 0.5 degree diameter at K-band, Ka-band, and EHF band.

21. The reflector of claim 15, wherein:

said reflector has a synthesized surface of modified-paraboloid shape; and

said synthesized surface forms identically-sized beams of 0.5 degree diameter at C-band, X-band, and Ku band.

22. The reflector of claim 15, wherein:

said reflector is sized to have an aperture D according to:

D = 70 x (wavelength (at 20.2 GHz)) / (half-power beam-width)

to produce said required beam size at a K-band frequency taking reflector shaping into account.

23. A feed array for an antenna system, comprising:
a plurality of high-efficiency multi-mode circular horns, wherein:
said feed array is focused at a lowest frequency band; and
said feed array is defocused at a highest frequency band.

24. The feed array of claim 23, wherein:
said feed array is defocused by 0.25 inch at EHF-band;
said feed array is defocused by 0.1 inch at Ka-band; and
said feed array is focused at K-band.

25. The feed array of claim 23, wherein:
said feed array broadens an EHF beam and a Ka beam from 0.4 degrees to 0.5 degrees; and
said feed array forms a 0.5 degree beam at K-band.

26. The feed array of claim 23, wherein:
a horn of said plurality of high-efficiency multi-mode circular horns of said feed array has an aperture diameter and a waveguide diameter;
said horn has a first step, between said aperture diameter and said waveguide diameter, at which the diameter of the circular cross-section of said horn abruptly changes;
said horn has a second step, between said first step and said waveguide diameter, at which the diameter of the circular cross-section of said horn abruptly changes.

27. The feed array of claim 23, wherein:
said feed array has a maximum feed size of 0.892 inch; and
each of said plurality of high-efficiency multi-mode circular horns of said feed array is connected to a distinct compact 6-port OMT/polarizer wherein said feed array provides dual-circular polarization capability at each of

the K, Ka, and EHF frequency bands.

28. The feed array of claim 23, wherein:

said feed array has a maximum feed size of 0.892 inch; and

each of said plurality of high-efficiency multi-mode circular horns of said feed array is connected to a distinct compact 6-port OMT/polarizer wherein said feed array provides dual-circular polarization capability at each of the C, X, and Ku frequency bands.

29. A satellite communication system comprising:

a radio frequency communication system;

an antenna system connected to said radio frequency communication system, wherein said antenna system includes:

a reflector having a non-frequency selective reflector surface, wherein:

said reflector is sized to produce a required beam size at a K-band frequency;

said reflector is oversized at an EHF-band frequency;

said reflector surface is a synthesized surface of modified-paraboloid shape;

said synthesized reflector surface is moderately shaped and disproportionately broadens EHF-band and Ka-band beams compared to K-band beams;

said synthesized reflector surface forms a 0.5 degree beam at K-band, Ka-band, and EHF band;

a multi-beam, multi-band feed array located at a focal point of said reflector, said feed array including a plurality of high-efficiency multi-mode circular horns, wherein:

said feed array is focused at a K-band frequency;

said feed array is defocused at a Ka-band frequency and an EHF-

band frequency;

a horn of said plurality of high-efficiency multi-mode circular horns of said feed array has an aperture diameter and a waveguide diameter;

said horn has a first step, between said aperture diameter and said waveguide diameter, at which the diameter of the circular cross-section of said horn abruptly changes; and

said horn has a second step, between said first step and said waveguide diameter, at which the diameter of the circular cross-section of said horn abruptly changes.

30. The satellite communication system of claim 29, wherein said reflector is an offset reflector.

31. The satellite communication system of claim 29, wherein said reflector is an axi-symmetric reflector.

32. The satellite communication system of claim 29, further including a ground terminal that simultaneously communicates with multiple satellites.

33. The satellite communication system of claim 29, further including an aircraft terminal that simultaneously communicates with multiple satellites.

34. A method of propagating a multi-beam, multi-band radio signal comprising steps of:

forming a plurality of multi-band beams wherein a lowest frequency band is formed in a focused mode and a higher frequency band is formed in a defocused mode; and

reflecting said multi-band beams off a shaped reflector to form congruent multi-band beams that are contiguous.

35. The method of claim 34, wherein said forming step comprises:

forming a K-band beam in a focused mode while forming a Ka-band beam and an EHF-band beam in a defocused mode so that said Ka-band beam and said EHF-band beam are broadened more than said K-band beam.

36. The method of claim 34, wherein said forming step comprises:

forming a C-band beam in a focused mode while forming an X-band beam and a Ku-band beam in a defocused mode so that said X-band beam and said Ku-band beam are broadened more than said C-band beam.

37. The method of claim 34, wherein said reflecting step comprises:

reflecting a K-band beam, a Ka-band beam, and an EHF-band beam from a synthesized reflector surface; and

disproportionately broadening said EHF-band beam and said Ka-band beam compared to said K-band beam; and

forming a 0.5 degree beam at K-band, Ka-band, and EHF band.

38. The method of claim 34, wherein said reflecting step comprises:

reflecting a C-band beam, an X-band beam, and a Ku-band beam from a synthesized reflector surface; and

disproportionately broadening said Ku-band beam and said X-band beam compared to said C-band beam; and

forming a 0.5 degree beam at C-band, X-band, and Ku band.

39. The method of claim 34, wherein said forming step further includes a step of forming a circularly polarized beam using an OMT/polarizer.

40. The method of claim 34, wherein said forming step further includes a step of forming a multi-band beam using a beam forming network.

41. The method of claim 34 further including a step of simultaneously communicating between a ground terminal and multiple satellites using said plurality of multi-band beams.

42. The method of claim 34 further including a step of simultaneously communicating between an aircraft terminal and multiple satellites using said plurality of multi-band beams.